

AMENDMENTS TO THE CLAIMS

This listing of claims will replace all prior versions, and listings, of claims in the application:

Claims:

1. (Previously Presented) A method of treating a subterranean formation comprising:

providing a gelled liquid hydrocarbon treatment fluid comprising a liquid hydrocarbon and a gelling agent that comprises a polyvalent metal salt of a phosphonic acid ester, and

treating the subterranean formation with the gelled liquid hydrocarbon treatment fluid.

2. (Previously Presented) The method of claim 1 wherein the gelled liquid hydrocarbon treatment fluid further comprises one element selected from the group consisting of water, bases, and combinations thereof.

3. (Currently Amended) The method of claim 1 wherein the liquid hydrocarbon [[is]] comprises at least one liquid hydrocarbon selected from the group consisting of α -olefins, internal olefins, alkanes, aromatic solvents, cycloalkanes, liquefied petroleum gases, kerosene, diesel oil, gas oil, fuel oil, petroleum distillates, crude oil mixtures, and mixtures thereof an α -olefin, an internal olefin, an alkane, an aromatic solvent, a cycloalkane, a liquefied petroleum gas, kerosene, a diesel oil, a gas oil, a fuel oil, a petroleum distillate, a crude oil mixture, and any mixture thereof.

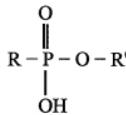
4. (Original) The method of claim 1 wherein the liquid hydrocarbon is designed for use with CO₂.

5. (Previously Presented) The method of claim 1 wherein the polyvalent metal salt of a phosphonic acid ester is formed by a metathesis reaction comprising an alkali metal or an ammonium salt of the phosphonic acid ester.

6. (Previously Presented) The method of claim 1 wherein the polyvalent metal salt of a phosphonic acid ester is formed by a metathesis reaction comprising a phosphonic acid dialkyl ester.

7. (Previously Presented) The method of claim 1 wherein the polyvalent metal salt of a phosphonic acid ester is formed from the reaction of an activator composition that comprises

a source of polyvalent metal ions and a phosphonic acid ester, the phosphonic acid ester having the formula:



wherein R or R' comprises a hydrocarbon group having about 1 to about 30 carbon atoms that comprises a linear or branched alkyl, alkenyl, aryl, alkylaryl, arylalkyl, cycloalkyl, alkyl ether, aryl ether, alkyl aryl ether, or a mixture thereof; and R or R' comprises a hydrocarbon group having from about 1 to about 6 carbon atoms.

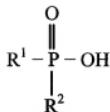
8. (Currently Amended) The method of claim 7 wherein the polyvalent metal ions [[are]] comprise at least one ion selected from the group consisting of aluminum ions, gallium ions, lanthanum ions, ruthenium ions, iron ions, lanthanide rare earth series ions, and combinations thereof an aluminum ion, a gallium ion, a lanthanum ion, a ruthenium ion, an iron ion, a lanthanide rare earth series ion, and any combination thereof.

9. (Original) The method of claim 7 wherein the polyvalent metal ions comprise ions having a +3 oxidation state.

10. (Currently Amended) The method of claim 7 wherein the activator composition [[is]] comprises at least one activator composition selected from the group consisting of ferrie iron salts, aluminum chloride, sodium aluminate, aluminum isopropoxide, and combinations thereof a ferric iron salt, aluminum chloride, sodium aluminate, aluminum isopropoxide, and any combination thereof.

11. (Previously Presented) The method of claim 1 wherein the gelling agent further comprises a polyvalent metal salt of an organophosphinic acid formed by a metathesis reaction comprising an organophosphinic acid alkyl ester.

12. (Previously Presented) The method of claim 1 wherein the gelling agent further comprises a polyvalent metal salt of an organophosphinic acid formed from a reaction of an activator composition that comprises a source of polyvalent metal ions and an organophosphinic acid, the organophosphinic acid having the formula:



wherein R¹ or R² comprises a hydrocarbon group having about 1 to about 30 carbon atoms that comprises a linear or branched alkyl, alkenyl, aryl, alkylaryl, arylalkyl, cycloalkyl, alkyl ether, aryl ether, alkyl aryl ether, or a mixture thereof; and R¹ or R² comprises a hydrocarbon group having from about 1 to about 6 carbon atoms.

13. (Currently Amended) The method of claim 12 wherein the source of polyvalent metal ions [[is]] comprises at least one source of polyvalent metal ions selected from the group consisting of aluminum ions, gallium ions, lanthanum ions, ruthenium ions, iron ions, lanthanide rare earth series ions, and combinations thereof an aluminum ion, a gallium ion, a lanthanum ion, a ruthenium ion, an iron ion, a lanthanide rare earth series ion, and any combination thereof.

14. (Original) The method of claim 12 wherein the polyvalent metal ions comprise ions having a +3 oxidation state.

15. (Original) The method of claim 1 wherein the gelled liquid hydrocarbon treatment fluid comprises a surfactant.

16. (Currently Amended) The method of claim 15 wherein the surfactant [[is]] comprises at least one surfactant selected from the group consisting of imidazoline, fatty acid soaps, fatty acids, dioctyl sulphosuccinate, sodium alkyl benzene sulphonate, fatty acid esters, fatty acid alkanolamides, amido betaines, and combinations thereof a fatty acid soap, a fatty acid, dioctyl sulphosuccinate, sodium alkyl benzene sulphonate, a fatty acid ester, a fatty acid alkanolamides, an amido betaine, and any combination thereof.

17. (Original) The method of claim 15 wherein the surfactant is present in the gelled liquid hydrocarbon treatment fluid in an amount in the range of from about 0.1% to about 10% based on the gelling agent.

18. (Original) The method of claim 1 wherein the gelled liquid hydrocarbon treatment fluid comprises an enhancer.

19. (Original) The method of claim 18 wherein the enhancer provides at least some alkalinity to the gelled liquid hydrocarbon treatment fluid.

20. (Original) The method of claim 18 wherein the enhancer has the general formula C_nH_mO_xN_y, wherein n is from about 1 to about 50, m is from about 0 to about the number

necessary to satisfy the valence of the enhancer, x is from about 1 to about 10, and y is from about 0 to about 10.

21. (Currently Amended) The method of claim 18 wherein the enhancer [[is]] comprises at least one enhancer selected from the group consisting of ethoxylated amines, triethanolamine, N,N-dibutyl ethanol amine, oxyalkylated di-C₂-C₈-alkyl amines, N,N-di-loweralkyl fatty amine, oxyalkylated fatty amines, monoammonium citrate, bis(hydroxyethyl) tallowamine, ethoxylated dehydroabietylamine, and mixtures thereof an ethoxylated amine, triethanolamine, N,N-dibutyl ethanol amine, an oxyalkylated di-C₂-C₈-alkyl amine, N,N-di-loweralkyl fatty amine, an oxyalkylated fatty amine, monoammonium citrate, bis(hydroxyethyl) tallowamine, ethoxylated dehydroabietylamine, and any mixture thereof.

22. (Original) The method of claim 1 wherein treating the subterranean formation involves fracturing a portion of the subterranean formation.

23. (Original) The method of claim 22 wherein the gelled liquid hydrocarbon treatment fluid comprises proppant.

24. (Original) The method of claim 1 wherein treating the subterranean formation involves providing sand control to at least a portion of the subterranean formation.

25. (Original) The method of claim 24 wherein the gelled liquid hydrocarbon treatment fluid comprises gravel.

26. (Currently Amended) The method of claim 23 or 25 wherein the proppant or gravel [[is]] comprises at least one proppant or gravel selected from the group consisting of nut shells, resin coated nut shells, graded sand, resin coated sand, sintered bauxite, particulate ceramic materials, glass beads, particulate polymeric materials, and combinations thereof a nut shell, a resin-coated nut shell, graded sand, resin-coated sand, sintered bauxite, a particulate ceramic material, a glass bead, a particulate polymeric material, and any combination thereof.

27. (Original) The method of claim 1 wherein the gelled liquid hydrocarbon treatment fluid comprises water, the water being present in an amount of at least about 0.05% by the total treatment fluid volume.

28. (Original) The method of claim 1 wherein the gelled liquid hydrocarbon treatment fluid further comprises a breaker, the breaker being present in an amount sufficient to reduce the viscosity of the gelled liquid hydrocarbon treatment fluid at a desired time.

29. (Original) The method of claim 28 wherein the breaker comprises a delayed gel breaker.

30. (Original) The method of claim 29 wherein the delayed gel breaker comprises an encapsulated delayed gel breaker.

31. (Original) The method of claim 29 wherein the delayed gel breaker is present in an amount in the range of from about 0.01% to about 3% w/v.

32. (Currently Amended) The method of claim 28 wherein the breaker [[is]] comprises at least one breaker selected from the group consisting of hard burned magnesium oxide, ~~alkali metal carbonates, alkali metal bicarbonate, alkali metal acetate, alkaline earth metal oxides, alkali metal hydroxides, amines, weak acids, and combinations thereof an alkali metal carbonate, an alkali metal bicarbonate, an alkali metal acetate, an alkaline earth metal oxide, an alkali metal hydroxide, an amine, a weak acid, and any combination thereof.~~

33. (Original) The method of claim 28 wherein the breaker comprises a reducing agent that is capable of reducing ferric iron to ferrous iron.

34. (Currently Amended) The method of claim 33 wherein the reducing agent [[is]] comprises at least one reducing agent selected from the group consisting of stannous chloride, thioglycolic acid, hydrazine sulfate, sodium diethyldithiocarbamate, sodium dimethyldithiocarbamate, sodium hypophosphite, potassium iodide, hydroxylamine hydrochloride, 2-mercaptoethanol, ascorbic acid, sodium thiosulfate, sodium dithionite, sodium sulfite, and combinations any combination thereof.

35. (Original) The method of claim 28 wherein the breaker is present in an amount of 0.01% to about 3% of the volume of the treatment fluid.

36. (Original) The method of claim 1 wherein the treating the subterranean formation involves using the gelled liquid hydrocarbon treatment fluid to provide a plugging agent to a portion of the subterranean formation or a portion of a well bore penetrating the subterranean formation.

37. (Original) The method of claim 1 wherein treating the subterranean formation involves using the gelled liquid hydrocarbon treatment fluid as a well bore cleanup fluid.

38. (Original) The method of claim 1 wherein treating the subterranean formation involves using the gelled liquid hydrocarbon treatment fluid to perform a viscous sweep of a

portion of the subterranean formation or a portion of a well bore penetrating the subterranean formation.

39. (Original) The method of claim 1 wherein treating the subterranean formation involves insulating a portion of the subterranean formation, a portion of a well bore penetrating the subterranean formation, or a tubing placed in a well bore penetrating the subterranean formation.

40. (Original) The method of claim 1 further comprising the step of preparing the gelled liquid hydrocarbon treatment fluid at the location of the subterranean formation.

41. (Original) The method of claim 1 further comprising the step of preparing the gelled liquid hydrocarbon treatment fluid at a location away from the subterranean formation and transporting the gelled liquid hydrocarbon treatment fluid to the subterranean formation.

42. (Previously Presented) A method of fracturing a portion of a subterranean formation comprising:

providing a gelled liquid hydrocarbon fracturing fluid comprising a gelling agent that comprises a polyvalent metal salt of a phosphonic acid ester, and

contacting the portion of the subterranean formation with the gelled liquid hydrocarbon fracturing fluid under conditions effective to create or enhance at least one fracture in the subterranean formation.

43. (Previously Presented) The method of claim 42 wherein the gelled liquid hydrocarbon fracturing fluid further comprises one element selected from the group consisting of water, bases, and combinations thereof.

44. (Currently Amended) The method of claim 42 wherein the gelled liquid hydrocarbon fracturing fluid [[is]] comprises at least one liquid hydrocarbon selected from the group consisting of α -olefins, internal olefins, alkanes, aromatic solvents, cycloalkanes, liquefied petroleum gas, kerosene, diesel oil, gas oil, fuel oil, petroleum distillates, crude oil mixtures, and combinations thereof an α -olefin, an internal olefin, an alkane, an aromatic solvent, a cycloalkane, a liquefied petroleum gas, kerosene, a diesel oil, a gas oil, a fuel oil, a petroleum distillate, a crude oil mixture, and any mixture thereof.

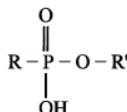
45. (Previously Presented) The method of claim 42 wherein the polyvalent metal salt of a phosphonic acid ester is present in an amount in the range of from about 0.1% to about 10% w/v.

46. (Previously Presented) The method of claim 42 wherein the polyvalent metal salt of a phosphonic acid ester is present in an amount in the range of from about 0.2% to about 5% w/v.

47. (Previously Presented) The method of claim 42 wherein the polyvalent metal salt of a phosphonic acid ester is formed by a metathesis reaction comprising an alkali metal or an ammonium salt of the phosphonic acid ester.

48. (Previously Presented) The method of claim 42 wherein the polyvalent metal salt of a phosphonic acid ester is formed by a metathesis reaction comprising a phosphonic acid dialkyl ester.

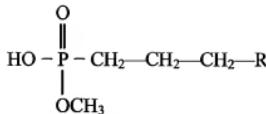
49. (Previously Presented) The method of claim 42 wherein the polyvalent metal salt of a phosphonic acid ester is formed from the reaction of an activator composition that comprises a source of polyvalent metal ions and a phosphonic acid ester, the phosphonic acid ester having the formula:



wherein R or R' comprises a hydrocarbon group having about 1 to about 30 carbon atoms that comprises a linear or branched alkyl, alkenyl, aryl, alkylaryl, arylalkyl, cycloalkyl, alkyl ether, aryl ether, alkyl aryl ether, or a mixture thereof; and R or R' comprises a hydrocarbon group having from about 1 to about 6 carbon atoms.

50. (Original) The method of claim 49 wherein the polyvalent metal ions comprise ions having a +3 oxidation state.

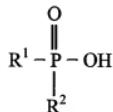
51. (Previously Presented) The method of claim 42 wherein the polyvalent metal salt of a phosphonic acid ester is formed from the reaction of an activator composition that comprises a source of polyvalent metal ions and a phosphonic acid ester, the phosphonic acid ester having the formula:



where R represents a hydrocarbon group having the general formula $\text{C}_n\text{H}_{2n+1}$, where n is from about 3 to about 21.

52. (Previously Presented) The method of claim 42 wherein the gelling agent further comprises a polyvalent metal salt of an organophosphinic acid formed by a metathesis reaction comprising an organophosphinic acid alkyl ester.

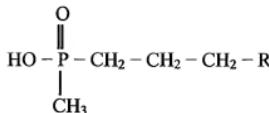
53. (Previously Presented) The method of claim 42 wherein the gelling agent further comprises a polyvalent metal salt of an organophosphinic acid formed from a reaction of an activator composition that comprises a source of polyvalent metal ions and an organophosphinic acid, the organophosphinic acid having the formula:



wherein R^1 or R^2 comprises a hydrocarbon group having about 1 to about 30 carbon atoms that comprises a linear or branched alkyl, alkenyl, aryl, alkylaryl, arylalkyl, cycloalkyl, alkyl ether, aryl ether, alkyl aryl ether, or a mixture thereof; and R^1 or R^2 comprises a hydrocarbon group having from about 1 to about 6 carbon atoms.

54. (Original) The method of claim 53 wherein the source of polyvalent metal ions comprise ions having a +3 oxidation state.

55. (Previously Presented) The method of claim 42 wherein the gelling agent further comprises a polyvalent metal salt of an organophosphinic acid formed from a reaction of an activator composition comprising a source of polyvalent metal ions and an organophosphinic acid, the organophosphinic acid having the formula:



where R represents a linear or branched alkyl chain having the general formula $\text{C}_n\text{H}_{2n+1}$, where n is from about 3 to about 21.

56. (Original) The method of claim 42 wherein the gelled liquid hydrocarbon treatment fluid comprises an enhancer.

57. (Original) The method of claim 42 wherein the gelled liquid hydrocarbon treatment fluid comprises a surfactant.

58. (Currently Amended) The method of claim 56 wherein the enhancer has the general formula $\text{C}_n\text{H}_m\text{O}_x\text{N}_y$, wherein n is about 1 to about 50, m is about 0 to about the number necessary to satisfy the valence of the enhancer, x is about 1 to about 10, and y is about 0 to about 10.

59. (Original) The method of claim 42 wherein the gelled liquid hydrocarbon fracturing fluid comprises proppant.

60. (Currently Amended) The method of claim [[58]] 59 wherein the proppant is present in an amount in the range of from about 1 to about 32 pounds of proppant per gallon of treatment fluid.

61. (Currently Amended) The method of claim 59 wherein the proppant [[is]] comprises at least one proppant selected from the group consisting of nut shells, resin-coated nut shells, graded sand, resin-coated sand, sintered bauxite, particulate ceramic materials, glass beads, particulate polymeric materials, and combinations thereof a nut shell, a resin-coated nut shell, graded sand, resin-coated sand, sintered bauxite, a particulate ceramic material, a glass bead, a particulate polymeric material, and any combination thereof.

62. (Original) The method of claim 42 wherein the gelled liquid hydrocarbon fracturing fluid further comprises a breaker, the breaker being present in an amount sufficient to reduce the viscosity of the gelled liquid hydrocarbon treatment fluid at a desired time.

63. (Original) The method of claim 62 wherein the breaker is present in an amount of about 0.01% to about 3% w/v.

64. (Previously Presented) A method of providing sand control to a portion of a subterranean formation comprising:

providing a gelled liquid hydrocarbon gravel pack fluid that comprises gravel particulates and a gelling agent that comprises a polyvalent metal salt of a phosphonic acid ester; and

contacting the portion of the subterranean formation with the gelled liquid hydrocarbon gravel pack fluid so as to form a gravel pack near the portion of the subterranean formation.

65. (Currently Amended) The method of claim 64 wherein the gelled liquid hydrocarbon gravel pack fluid further comprises at least one element selected from the group consisting of water, ~~bases, and combinations~~ a base, and any combination thereof.

66. (Currently Amended) The method of claim 64 wherein the gelled liquid hydrocarbon gravel pack fluid [[is]] comprises at least one liquid hydrocarbon selected from the group consisting of α -olefins, internal olefins, alkanes, aromatic solvents, cycloalkanes, liquefied petroleum gas, kerosene, diesel oil, gas oil, fuel oil, petroleum distillates, crude oil mixtures, and mixtures thereof an α -olefin, an internal olefin, an alkane, an aromatic solvent, a cycloalkane, a liquefied petroleum gas, kerosene, a diesel oil, a gas oil, a fuel oil, a petroleum distillate, a crude oil mixture, and any mixture thereof.

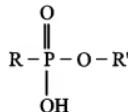
67. (Previously Presented) The method of claim 64 wherein the polyvalent metal salt of a phosphonic acid ester is present in an amount in the range of from about 0.1% to about 10% w/v.

68. (Previously Presented) The method of claim 64 wherein the polyvalent metal salt of a phosphonic acid ester is present in an amount in the range of from about 0.1% to about 5% w/v.

69. (Previously Presented) The method of claim 64 wherein the polyvalent metal salt of a phosphonic acid ester is formed by a metathesis reaction comprising an alkali metal or an ammonium salt of the phosphonic acid ester.

70. (Previously Presented) The method of claim 64 wherein the polyvalent metal salt of a phosphonic acid ester is formed by a metathesis reaction comprising a phosphonic acid dialkyl ester.

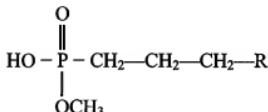
71. (Previously Presented) The method of claim 64 wherein the polyvalent metal salt of a phosphonic acid ester is formed from the reaction of an activator composition that comprises a source of polyvalent metal ions and a phosphonic acid ester, the phosphonic acid ester having the formula:



wherein R or R' comprises a hydrocarbon group having about 1 to about 30 carbon atoms that comprises a linear or branched alkyl, alkenyl, aryl, alkylaryl, arylalkyl, cycloalkyl, alkyl ether, aryl ether, alkyl aryl ether, or a mixture thereof; and R or R' comprises a hydrocarbon group having from about 1 to about 6 carbon atoms.

72. (Original) The method of claim 71 wherein the polyvalent metal ions comprise ions having a +3 oxidation state.

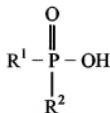
73. (Previously Presented) The method of claim 64 wherein the polyvalent metal salt of a phosphonic acid ester is formed from the reaction of an activator composition that comprises a source of polyvalent metal ions and a phosphonic acid ester, the phosphonic acid ester having the formula:



where R represents a hydrocarbon group having the general formula $\text{C}_n\text{H}_{2n+1}$, where n is from about 3 to about 21.

74. (Previously Presented) The method of claim 64 wherein the gelling agent further comprises a polyvalent metal salt of an organophosphinic acid formed by a metathesis reaction comprising an organophosphinic acid alkyl ester.

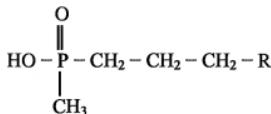
75. (Previously Presented) The method of claim 64 wherein the gelling agent further comprises a polyvalent metal salt of an organophosphinic acid formed from a reaction of an activator composition that comprises a source of polyvalent metal ions and an organophosphinic acid, the organophosphinic acid having the formula:



wherein R¹ or R² comprises a hydrocarbon group having about 1 to about 30 carbon atoms that comprises a linear or branched alkyl, alkenyl, aryl, alkylaryl, arylalkyl, cycloalkyl, alkyl ether, aryl ether, alkyl aryl ether, or a mixture thereof; and R¹ or R² comprises a hydrocarbon group having from about 1 to about 6 carbon atoms.

76. (Original) The method of claim 75 wherein the source of polyvalent metal ions comprise ions having a +3 oxidation state.

77. (Previously Presented) The method of claim 64 wherein the gelling agent further comprises a polyvalent metal salt of an organophosphinic acid formed from a reaction of an activator composition comprising a source of polyvalent metal ions and an organophosphinic acid, the organophosphinic acid having the formula:



where R represents a linear or branched alkyl chain having the general formula C_nH_{2n+1}, where n is from about 3 to about 21.

78. (Original) The method of claim 64 wherein the gelled liquid hydrocarbon gravel pack fluid comprises an enhancer.

79. (Original) The method of claim 64 wherein the gelled liquid hydrocarbon gravel pack fluid comprises a surfactant.

80. (Original) The method of claim 78 wherein the enhancer has the general formula C_nH_mO_xN_y, wherein n is about 1 to about 50, m is about 0 to about the number necessary to satisfy the valence, x is about 1 to about 10, and y is about 0 to about 10.

81. (Original) The method of claim 64 wherein the gravel is present in an amount in the range of from about 1 to about 32 pounds of gravel per gallon of treatment fluid.

82. (Original) The method of claim 64 wherein the gelled liquid hydrocarbon gravel pack fluid further comprises a breaker, the breaker being present in an amount sufficient to reduce the viscosity of the gelled liquid hydrocarbon treatment fluid at a desired time.

83. (Original) The method of claim 82 wherein the breaker is present in an amount of about 0.01% to about 3% w/v.

84. - 142. (Cancelled)